ChangSeob Song

Center for Intelligent & Interactive Robotics, Korea Institute of Science and Technology
E-mail: css@kist.re.kr, songcs7751@gmail.com / Mobile: +82 10 4477 7751

EDUCATION

Korea University Seoul, Korea
M. S. in Mechanical Engineering. GPA: 4.25/4.5 (97.1/100) Sep. 2021 – Aug. 2023

- Academic-research cooperative program at Korea Institute of Science and Technology (KIST)
- Adivisor: Dr. Donghyun Hwang (KIST), Prof. Shinsuk Park (KU)
- Thesis title: Study on Magnetic Granular Jamming Module with Rapid Stiffness Tunability

Korea University Seoul, Korea
B. S. in Mechanical Engineering. GPA: 4.11/4.5 (96.1/100) Mar. 2015 – Feb. 2021
(Note: Absence during Feb. 2017 - Nov. 2018 due to military service)

- Graduated with great honor; high honors for five semesters.
- Thesis title: Simulation of Automated Machine Tending by Mobile Manipulator

RESEARCH INTERESTS

Bio-inspired robotics, Soft Robotics, Material robotics, Embodied Intelligence, Morphological computation, Variable stiffness mechanisms, Magnetically actuated robots, Continuum robots, Compliant mechanisms, and Tele-operation.

RESEARCH EXPERIENCE

Precision Robotics and Intelligent Mechatronics Lab Korea Institute of Science and Technology, Seoul, Korea
Student Researcher, Research Scientist (Advisor: Donghyun Hwang) Mar. 2021 – present

Magnetic Granular Jamming (MGJ)

- Proposed novel MGJ mechanism that is inherently more rapid and precise than pneumatic jamming.
- Presented MGJ's design principle and demonstrated its feasibility on grasping, locomotion, and tangible user interface.
- Developed module prototypes, characterized four major components, and demonstrated rapid and precision stiffness tunability.

Rapid Jamming Mechanism-Based Modular High-Rigidity Continuum Robot

- Developed magnetically actuated hole-type ball joint for continuum robots with rapid and high stiffness tunability.
- Designed and simulated embedded magnetic circuit; fabricated high-precision ball joint module.
- Integrated with diaphragm flexure structure to achieve compliant behavior; implemented tendon-driven actuation.

Tele-Operation/Monitoring System for Medical Devices in Intensive Care Units

- Designed 2-DoF belt-driven positioner (average positioning error: 101 μm) to precisely translate end-effector.
- Collaborated on system integration: HW (mechanism design, machining), SW (system architecture, MCU, GUI).
- Conducted reliability assessment of developed system for 38,221 cycles and achieved a success rate of 97.35%.

Mechatronics & Field Robotics Lab Korea University, Seoul, Korea
Undergraduate Researcher (Advisor: Daehie Hong) Sep. 2020 – Dec. 2020

Simulation of Automated Machine Tending with an Open-Source Mobile Manipulator

- Proposed simulation environment for automated machine tending of mobile manipulators in smart factories.
- Evaluated machine tending performance using three performance indices: task duration/distance, completion, and efficiency.

PUBLICATIONS

C. Song†, G. Yang†, S. Park, N. Jang, S. Jeon, S. Oh, and D. Hwang, "On the Design of Integrated Tele-Monitoring/ Operation System for Therapeutic Devices in Isolation Intensive Care Unit," *IEEE Robotics and Automation Letters*, **7**, 8705 (2022).

C. Song, S. Park, and D. Hwang, "Magnetic Granular Jamming: Untethered System with Rapid and Precision Stiffness Tunability," *Science Advances*. (Under review)

N. Jang, **C. Song**, G. Yang, D. Hwang, "Experimental Reliability Assessment on the System to Tele-operate Medical Ventilators in Intensive Care Unit," *IEEE Transactions on Reliability*. (In preparation)

G. Yang†, **C. Song**†, N. Jang, D. Hwang, "Vision-based Hand Tracking for Teleoperation of Ventilator in Isolation Intensive Care Unit to Reduce Time Delay," *Journal of Telemedicine and Telecare*. (In preparation)

INTERNATIONAL CONFERENCES

C. Song†, G. Yang†, S. Park, N. Jang, S. Jeon, S. Oh, and D. Hwang, "On the Design of Integrated Tele-Monitoring/ Operation System for Therapeutic Devices in Isolation Intensive Care Unit," *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Kyoto, Japan, Oct. 2022. (oral)

C. Song and D. Hwang, "Stiffening Iron Powder to Grasp Objects," *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) Late-Breaking Results posters*, Kyoto, Japan, Oct. 2022. (poster)

N. Jang, **C. Song**, G. Yang, D. Hwang, "Experimental Reliability Assessment on the System to Tele-operate Medical Ventilators in Intensive Care Unit," *The 45th Annual International Conference of the IEEE Engineering in Medicine & Biology Conference (EMBC)*, Sydney, Australia, Jul. 2023. (poster)

DOMESTIC CONFERENCES

C. Song and D. Hwang, "Magnetic Grain-based Rapid Jamming Mechanism," *Samsung Global Technology Symposium*, Seoul, Korea, Apr. 2023. (poster)

C. Song and D. Hwang, "Magnetic Grain-based Rapid Variable-Stiffness Mechanism," *The 18th Korea Robotics Society Annual Conference (KRoC)*, Pyeongchang, Korea, Feb. 2023. (poster)

C. Song, G. Yang, S. Park, N. Jang, S. Jeon, S. Oh, and D. Hwang, "Development of Master-slave System for Tele-monitoring/operating Mechanical Ventilators in Isolation Intensive Care Unit," *The 17th Korea Robotics Society Annual Conference (KRoC)*, Pyeongchang, Korea, Feb. 2022. (oral)

N. Jang, **C. Song**, G. Yang, S. Park, and D. Hwang, "Tele-Monitoring/Operation System for Therapeutic Devices in Isolation Intensive Care Unit," *The 17th Korea Robotics Society Annual Conference (KRoC) RED Show*, Pyeongchang, Korea, Feb. 2022. (poster)

PATENTS

D. Hwang and **C. Song**, "Magnetic Jamming Mechanism," Korea Patent Application No. 10-2023-0046420, Apr. 2023.

D. Hwang, **C. Song**, G. Yang, S. Park, and N. Jang, "Remote Monitoring and Remote Operation System for Therapeutic Devices," Korea Patent Application No. 10-2023-0002485, Jan. 2023.

AWARDS AND HONORS

KIST Student Excellence Award for outstanding achievements and unwavering commitment during academic-research cooperative program, KIST, Aug. 2023.

Samsung Global Technology Symposium Connect Award for presentation "Magnetic Grain-based Rapid Jamming Mechanism," Samsung Global Technology Symposium, Apr. 2023.

AIR Paper Award for outstanding publication "On the Design of Integrated Tele-Monitoring/Operation System for Therapeutic Devices in Isolation Intensive Care Unit," AI and Robotics Institute, KIST, Dec. 2022.

Great Honor for graduating with excellent academic performance, KU, Feb. 2021.

Semester High Honors for 2015 spring, 2015 fall, 2016 spring, 2016 fall, and 2020 spring semester, KU.

EXHIBITIONS AND DEMONSTRATIONS

Integrated Tele-monitoring and Tele-operation Systems for Therapeutic Medical Devices in Isolation ICU

- **Global Healthcare Medical Expo** Dubai World Trade Centre, Dubai, UAE, Jan. 2024. (Planned)
- **K-Hospital+Health Tech Fair** COEX, Seoul, Korea, Sep. 2023.
- **Korea Science & Technology Fair** KINTEX, Goyang-si, Korea, Dec. 2021.

Barista Robot System with Robotic Hand Capable of Somatosensory Feedback

- **ROBOTWORLD 2023 – International Robot Exhibition** KINTEX, Goyang-si, Korea, Oct. 2023.
- **KIST Roboteria Barista Robot Service** KIST, Seoul, Korea, Jun. 2023 - Present.

TEACHING AND LEADERSHIP EXPERIENCE

Research Mentor, KIST Sep. 2022 – present

- Mentored four undergraduates on hardware implementation (CAD, rapid-prototyping, machining, part assembly).

1. Modeling and fabrication of MGJ module.
2. Designing and machining of ABS covers for functional prototypes in tele-operation system.
3. Miniaturization of 3-DOF end-effector for manipulating physical user interfaces of medical devices.
4. Conceptualization and design of dual-layer shutter mechanism.

Team Leader, X-GARAGE Prototype Manufacturing Program, KU Jul. 2020 – Dec. 2020

- Supervised funded project presenting low-cost and high-payload electronic cart with velocity control feature.
- Played a leading role in development phase, i.e., hardware implementation and sensor/MCU programming.
- Demonstrated working performance with 70 kg weight on 10° inclined terrain.

Team Leader, Horang Nabi, Drone Club, KU Mar. 2020 – Dec. 2020

- Supervised project "Indoor trajectory tracking of quadcopters using optical flow sensor information."
- Designed trajectory tracking algorithm, allowing autonomous decision of direction and thrust by PD control.
- Programmed flight motions, tuned drone controller, and directed flying tests and demonstrations.

COMPUTER & HANDS-ON SKILLS

Hardware CAD (Solidworks), rapid prototyping (laser cutting, 3D printing), machining (lathe, milling), and part assembly.

FEA Software Magnetic field analysis (COMSOL Multiphysics AC/DC), Static analysis (ANSYS structural analysis).

Programming C, C++, Matlab, Python, Microprocessor (STM, AVR, Arduino), ROS, Qt Designer.

REFERENCES

Dr. Donghyun Hwang, Principal Researcher
Center for Robotics Research
Korea Institute of Science and Technology
+82-2-958-5732, donghyun@kist.re.kr

Prof. Shinsuk Park
Dept. of Mechanical Engineering
Korea University
+82-2-3290-3373, drsspark@korea.ac.kr

Dr. Sungwook Yang, Principal Researcher
Center for Robotics Research
Korea Institute of Science and Technology
+82-2-958-5747, swyang@kist.re.kr